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European Patent Office  
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(11) EP 1 040 806 A1

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:  
04.10.2000 Bulletin 2000/40

(51) Int Cl.7: A61F 13/15, A61L 15/20,  
C08J 9/00

(21) Application number: 99106115.1

(22) Date of filing: 01.04.1999

(84) Designated Contracting States:  
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE  
Designated Extension States:  
AL LT LV MK RO SI

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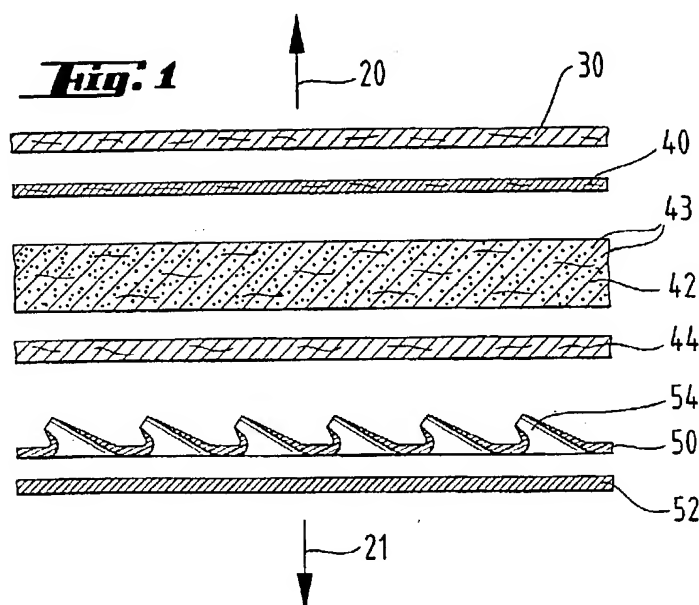
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(54) Resilient, three dimensional film comprising a compound increasing hydrophobicity, and its use in backsheets of absorbent articles

(57) The present invention relates to a resilient three dimensional web consisting of an apertured film with a resin integrated hydrophobicity increasing compound. It can be used in breathable absorbent articles like baby diapers, adult incontinence articles and in particular to sanitary napkins or pantliners to provided with an apertured layer in the backsheet for breathability. The aper-

tured film is made from a resilient, three dimensional web which consists of a liquid impervious polymeric film having apertures. The apertures form capillaries which are not perpendicular to the plane of the film but are disposed at an angle of less than 90° relative to the plane of the film. The polymeric film material comprises a compound which increases the hydrophobic behavior of the material and thereby improves the barrier performance.



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## Description

Field of the invention

5 [0001] The present invention relates to a resilient three dimensional web consisting of an apertured film with a resin integrated hydrophobicity increasing compound. It can be used in breathable absorbent articles like baby diapers, adult incontinence articles and in particular to sanitary napkins or pantliners to provided with an apertured layer in the backsheet for breathability. The apertured film is made from a resilient, three dimensional web which consists of a liquid impervious polymeric film having apertures. The apertures form capillaries which are not perpendicular to the plane of the film but are disposed at an angle of less than 90° relative to the plane of the film. The polymeric film material comprises a compound which increases the hydrophobic behavior of the material and thereby improves the barrier performance.

Background of the Invention

15 [0002] The primary consumer needs which underlie development in the absorbent article field, in particular sanitary napkins, catamenials, or pantliners is the provision of products providing both a high protection and comfort level.

[0003] One means for providing consumer comfort benefits in absorbent articles is by the provision of breathable products. Breathability has typically concentrated on the incorporation of so called 'breathable backsheets' in the absorbent articles.

20 [0004] Commonly utilised breathable backsheets are microporous films and apertured formed films having directional fluid transfer as disclosed in for example US 4 591 523. Both these types of breathable backsheets are vapour permeable allowing gaseous exchange with the environment. This thereby allows for the evaporation of a portion of the fluid stored in the core and increases the circulation of air within the absorbent article. The latter is particularly beneficial as it reduces the sticky feeling experienced by many wearers during use, commonly associated with the presence of an apertured formed film or film like topsheet.

25 [0005] A drawback associated with the use of breathable backsheets in absorbent articles is the negative effect on the protection level performance by leakage, known as wet through, onto the users garment. Although, breathable backsheets in principle only allow the transfer of materials in the gaseous state, physical mechanisms such as extrusion, diffusion and capillary action may still occur and result in the transfer of the fluids from the absorbent core through the backsheet and onto the users garments. In particular, these mechanisms become more dominant if the product is utilised during physical exertion, or for heavy discharge loads or over extended periods of time. Thus, whilst the incorporation of breathable backsheets in absorbent articles is highly desirable from a comfort standpoint, since the primary role of a backsheet still remains the prevention of liquid leakage, conventional breathable backsheets have not been satisfactorily incorporated into products.

30 [0006] The problem of wet through onto users garments due to the incorporation of such breathable backsheets in absorbent articles has indeed also been recognized in the art. Attempts to solve the problem have mainly resided in the use of multiple layer backsheets such as those illustrated in US 4 31 216. Similarly European patent application no. 710 471 discloses a breathable backsheet comprising an outer layer of a gas permeable, hydrophobic, polymeric fibrous fabric and an inner layer comprising an apertured formed film having directional fluid transport. The backsheet construction preferably has no liquid transport/wet through under certain specified test conditions. Also European patent application no. 710 472 discloses a breathable backsheet consisting of at least two breathable layers which are unattached to one another over the core area. The backsheet construction preferably has no liquid transport/wet through under certain specified test conditions.

35 [0007] US 4 713 068 discloses a breathable clothlike barrier for use as an outer cover for absorbent articles. The barrier comprises at least 2 layers, a first layer having a specified basis weight, fiber diameter and pore size and a second layer comprising a continuous film of poly (vinyl alcohol) having a specified thickness. The barrier also has a specified water vapour transmission rate and level of impermeability.

[0008] However, none of the above proposed solutions have been able to provide a fully satisfactory solution to the problem of breathable backsheet wet through under all conditions.

40 [0009] US 5,591,510 as well as WO 97/03118 and WO 97/03795 disclose an apertured film layer having capillaries which are disposed at an angle relative to the plain of the film, which films are referred to as slanted capillary films. This film structure is provided as a improvement for incorporation into clothing and garments which are breathable, yet non transmitting liquids toward the wearer of such garments. Also the use of such slanted capillary films is indicated in the context of absorbent articles but as a topsheet, particularly in figure 16 of US 5,591,510 the combination of such slanted capillary films together with an absorbent material is disclosed. However disposable absorbent articles similar to the present invention are disclosed in pending European application number 98101867.4 and 98101868.2.

45 [0010] It is generally known to improve the breathability performance and resistance to liquid passage of breathable

structures by increasing the hydrophobicity of the structure and better yet to introduce a surface energy gradient in order to drive liquid in a certain direction opposite that in which leakage is intended to be prevented. Such a surface energy gradient has been disclosed in PCT international application no. PCT/US96/20685, published 1997. This disclosure contains a very detailed description of the benefits of creating a fluid contact angle gradient between layers and surfaces and within a layer in order to improve leakage and strike through performance of breathable absorbent articles. One drawback of the surface energy gradient systems disclosed in this PCT publication is however that for generating the gradient it is needed to treat the surface. According to the present invention it has now been found that rendering a capillary apertured film layer, which can be used within a breathable backsheet system for absorbent articles, more hydrophobic than the most adjacent layer does provide a significant barrier performance improvement without the need for a surface treatment.

[0011] It is therefore an objective of the present invention to provide a film useable in a disposable absorbent article having improved comfort while maintaining an acceptable level of protection, i.e. being exceptionally leakage resistant by use of a surface energy gradient between layers but without the need to an additional surface treatment step of the layers.

#### Summary of the invention

[0012] The present invention relates to an apertured film with a resin integrated hydrophobicity increasing compound. Such a film provides excellent vapour and air permeability while being a barrier to liquid penetration. Such a film is particularly useful in breathable disposable absorbent articles of a layered construction such as baby diapers, adult incontinence articles and in particular sanitary napkins or panty liners. Also articles such as underarm sweat pads or shirt scholars may benefit from the present invention. Typically such articles are of layered construction with each layer or group of layers having a garment facing surface which is oriented to face in the direction of a garment during use of the article and a wearer facing surface facing in the opposite direction. Typically such articles comprise a liquid pervious topsheet forming the wearer facing surface of the article, an absorbent core and a breathable backsheet forming the garment facing surface of the article. The absorbent core is interposed between the topsheet and the backsheet. However, according to the present invention the absorbent core may provide the wearer facing surface of the article such that this surface of the core also provides the functions of the topsheet.

[0013] The film according to the present invention is a resilient three dimensional web, which consists of a liquid impervious polymeric film which has apertures. The apertures form capillaries which have side walls which extend away from a second surface of the film providing the web with three dimensionality. The capillaries have a first opening in the first surface of the film and a second opening at the end of the capillaries spaced apart from the second surface of the film. Importantly the capillaries extend away from the second surface of the film at an angle which is less than 90° in respect to the plain of the film.

[0014] In a preferred embodiment the capillaries are all substantially identical and preferably are homogeneously distributed across the film. Preferably a center axis of each capillary forms an angle between 85° and 20°, more preferably between 65° and 25° and most preferably between 55° and 30° with the plain of the film. The center axis is defined as the line which connects the center point of the first opening of a capillary and the center point of the second opening of a capillary.

[0015] For some embodiments it is also possible that the first opening of at least some of the capillaries is larger than the second opening of the respective capillary such that the capillaries themselves form cones which have an increase in capillary action in a direction towards their second opening. In yet another embodiment according to the present invention the capillaries are curved towards or appear bent back towards the plain of the film. In an alternative or in addition thereto the capillaries have a first and a second portion which are different in direction, form, shape, size or combinations thereof.

[0016] Also the second opening of at least some of the capillaries may be provided as slits. Slits are considered to be such forms in which the longest extend of an opening is at least 5 times the length of the smallest length of the opening.

[0017] In accordance with the present invention the polymeric film is made from a polymeric material composition in which the hydrophobicity of the polymeric material has been increased by a hydrophobic additive. Preferably the additive increases the fluid contact angle of the polymeric film material by at least 5°, more preferably by at least 10°, most preferably by a value of at least 20° relative to the same material without the additive. It is also desirable to have the absolute contact angle be more than 100° and preferably more than 120°.

[0018] The most preferred polymeric materials are polyethylene or polypropylene which are inherently hydrophobic. The increase of their hydrophobicity can be achieved with fluoro-chemical material such as oxazolidinones which are substituted with fluoro aliphatic material. A particular preferred and commercially available hydrophobic additive material is for example FX-1801 of the Minnesota Mining and Manufacturing Company St. Louis, USA.

[0019] The film according to the present invention is comprised in the breathable backsheet. It is located on the

garment facing surface of the absorbent core and comprises at least a first backsheet layer and preferably a second backsheet layer. If a second backsheet layer is present, then the first backsheet layer is positioned between the garment facing surface of the absorbent core and the wearer facing surface of the second backsheet layer. In order to provide the article with breathability all backsheet layers are at least water vapor permeable, preferably air permeable. Preferably the first backsheet layer is provided by the film according to the present invention. The film is used such that the first surface of the film provides the garment facing surface and the second film surface provides the wearer facing surface of the first backsheet layer.

[0020] In general the construction of the absorbent article can be such that the web comprising the film forms the wearer facing surface of the backsheet construction. In this way the directional liquid transport and the ability to close under pressure derivable from the angled capillaries provide the best leak through protection while maintaining optimum breathability for improved comfort.

#### Brief description of the drawings

[0021] Figure 1 shows a cross-sectional view of an absorbent article comprising all usual elements of such articles including a preferred embodiment of the breathable backsheet according to the present invention.

[0022] Figures 2 - 7 show particular alternative embodiments of the slanted capillaries used for the apertured film according to the present invention.

#### Detailed description of the invention

[0023] In the following the invention will be described in the context of absorbent articles which are also claimed. However it is recognized that other uses of apertured films also benefit from the improved properties of the film according to the present invention.

[0024] The present invention relates to absorbent disposable articles such as sanitary napkins, panty liners, incontinence products, sweat pads, breast pads and baby diapers. Typically such articles comprise the elements of a liquid pervious topsheet, a backsheet and an absorbent core intermediate said topsheet and said backsheet. According to the present invention the topsheet, backsheet and core may be selected from any of the known types of these components provided that they meet the desired comfort and protection performance requirements and conditions noted below and in the appended claims.

[0025] In general, the topsheet - if present - should have good liquid retention to maintain a dry surface and thereby keep the skin of the wearer dry; the absorbent core needs to provide enough absorbent capacity and allow the flow of vapour and/or air through it and the backsheet should prevent wet through (liquid permeability) to retain the absorbed fluid while being sufficiently breathable. Furthermore, the individual elements are joined, preferably using techniques such that the final product has the desired comfort and performance level.

[0026] In the following description of the absorbent articles of the invention the surface facing in the direction of the wearer is called wearer facing surface. In the drawings this direction is indicated by arrow 20. Further the surface facing in the direction of the garment is called garment facing surface and in the drawings this direction is indicated by arrow 21.

#### Absorbent article components

##### The topsheet

[0027] According to the present invention the absorbent article usually comprises a topsheet. The topsheets suitable for use herein may be any topsheet known in the art. In Figure 1 the topsheet is indicated with reference numeral 30.

[0028] The topsheets for use herein may comprise a single layer or a multiplicity of layers. In a preferred embodiment the topsheet comprises a first layer which provides the user facing surface of the topsheet and a second layer between the first layer and the absorbent structure/core. In addition another layer on the wearer facing surface of the first layer but only extending in the central zone or in parts of the peripheral zone of the article can be desirable to provide extra softness or extra liquid handling/retaining abilities (this design is usually referred to as "hybrid topsheet"). The topsheet typically extends across the whole of the absorbent structure and can extend into and form part of or all of the preferred sideflaps, side wrapping elements or wings.

[0029] The topsheet as a whole and hence each layer individually needs to be compliant, soft feeling, and non-irritating to the wearer's skin. It also can have elastic characteristics allowing it to be stretched in one or two directions. As used herein the topsheet hence refers to any layer or combination of layers whose principle function is the acquisition and transport of fluid from the wearer towards the absorbent core and containment of the absorbent core. In addition the topsheet of the present invention should have a high vapour permeability preferably also a high air permeability.

[0030] According to the present invention the topsheet may be formed from any of the materials available for this

purpose and known in the art, such as wovens, non wovens, films or combinations thereof. In a preferred embodiment of the present invention at least one of the layers of the topsheet comprises a liquid permeable apertured polymeric film. Preferably, the wearer facing and contacting layer is provided by a film material having apertures which are provided to facilitate liquid transport from the wearer facing surface towards the absorbent structure, as detailed for example in US 3 929 135, US 4 151 240, US 4 319 868, US 4 324 426, US 4 343 314 and US 4 591 523. However, even non-woven or woven substrates can be apertured to improve their function of liquid acquisition.

#### Absorbent core

[0031] According to the present invention the absorbent cores suitable for use herein may be selected from any of the absorbent cores or core system known in the art. As used herein the term absorbent core refers to any material or multiple material layers whose primary function is to absorb, store and distribute fluid. In Figure 1 the absorbent structure is shown to comprise 3 layers 40, 42, and 44.

[0032] The absorbent core of the present invention should have a high vapour permeability preferably also a high air permeability. The absorbent core preferably has a caliper or thickness of less than 12mm, preferably less than 8mm, more preferably less than 5mm, most preferably from 4mm to 2mm.

[0033] According to the present invention, the absorbent core can include the following components: (a) an optional primary fluid distribution layer preferably together with a secondary optional fluid distribution layer; (b) a fluid storage layer; (c) an optional fibrous ("dusting") layer underlying the storage layer; and (d) other optional components.

#### Primary/Secondary Fluid Distribution Layer

[0034] One optional component of the absorbent core according to the present invention, indicated as layer 40 in Figure 1, is a primary fluid distribution layer and a secondary fluid distribution layer. The primary distribution layer typically underlies the topsheet and is in fluid communication therewith. The topsheet transfers the acquired fluid to this primary distribution layer for ultimate distribution to the storage layer. This transfer of fluid through the primary distribution layer occurs not only in the thickness, but also along the length and width directions of the absorbent product. The also optional but preferred secondary distribution layer typically underlies the primary distribution layer and is in fluid communication therewith. The purpose of this secondary distribution layer is to readily acquire fluid from the primary distribution layer and transfer it rapidly to the underlying storage layer. This helps the fluid capacity of the underlying storage layer to be fully utilised. The fluid distribution layers can be comprised of any material typical for such distribution layers.

#### b Fluid Storage Layer

[0035] Positioned in fluid communication with, and typically underlying the primary or secondary distribution layers, is a fluid storage layer (42). The fluid storage layer can comprise any usual absorbent material or combinations thereof. It preferably comprises absorbent gelling materials usually referred to as "hydrogel", "superabsorbent", hydrocolloid" materials in combination with suitable carriers, which are indicated as particles (43) in Figure 1.

[0036] The absorbent gelling materials are capable of absorbing large quantities of aqueous body fluids, and are further capable of retaining such absorbed fluids under moderate pressures. The absorbent gelling materials can be dispersed homogeneously or non-homogeneously in a suitable carrier. The suitable carriers, provided they are absorbent as such, can also be used alone.

[0037] Suitable absorbent gelling materials for use herein will most often comprise particles of a substantially water-insoluble, slightly cross-linked, partially neutralised, polymeric gelling material. This material forms a hydrogel upon contact with water. Such polymer materials can be prepared from polymerizable, unsaturated, acid-containing monomers which are well known in the art.

[0038] Suitable carriers include materials which are conventionally utilised in absorbent structures such as natural, modified or synthetic fibers, particularly modified or non-modified cellulose fibers, in the form of fluff and/or tissues. Suitable carriers can be used together with the absorbent gelling material, however, they can also be used alone or in combinations. Most preferred are tissue or tissue laminates in the context of sanitary napkins and panty liners.

[0039] An embodiment of the absorbent structure made according to the present invention comprises a double layer tissue laminate. These layers can be joined to each other for example by adhesive or melting a polymeric powder binder (e.g. PE powder), by mechanical interlocking, or by hydrogen bridge bonds. Absorbent gelling material or other optional material can be comprised between the layers.

[0040] Modified cellulose fibers such as the stiffened cellulose fibers can also be used. Synthetic fibers can also be used and include those made of cellulose acetate, polyvinyl fluoride, polyvinylidene chloride, acrylics (such as Orlon), polyvinyl acetate, non-soluble polyvinyl alcohol, polyethylene, polypropylene, polyamides (such as nylon), polyesters,

bicomponent fibers, tricomponent fibers, mixtures thereof and the like. Preferably, the fiber surfaces are hydrophilic or are treated to be hydrophilic. The storage layer can also include filler materials, such as Perlite, diatomaceous earth, Vermiculite, etc., to improve liquid retention.

[0041] If the absorbent gelling material is dispersed, non-homogeneously in a carrier, the storage layer can nevertheless be locally homogenous, i.e. have a distribution gradient in one or several directions within the dimensions of the storage layer. Non-homogeneous distribution can also refer to laminates of carriers enclosing absorbent gelling materials partially or fully.

[0042] An alternative are foam like or actual foam structures as liquid storage. There are open cell foams which absorb liquid and through chemical or surface interaction retain the liquid also under pressure. Such foams may be formed with a skin, thus providing on their wearer facing surface a smooth appearance which makes the use of a topsheet optional. Typical foams in this context are e. g. those disclosed in PCT publications WO 93/03699, WO 93/04092, WO 93/04113.

#### c Optional Fibrous ("Dusting") Layer

[0043] An optional component for inclusion in the absorbent core according to the present invention is a fibrous layer adjacent to, and typically underlying the storage layer identified by reference numeral 44 in Figure 1. This underlying fibrous layer is typically referred to as a "dusting" layer since it provides a substrate on which to deposit absorbent gelling material in the storage layer during manufacture of the absorbent core. Indeed, in those instances where the absorbent gelling material is in the form of macro structures such as fibers, sheets or strips, this fibrous "dusting" layer need not be included. However, this "dusting" layer provides some additional fluid-handling capabilities such as rapid wicking of fluid along the length of the pad.

#### d Other Optional Components of the absorbent structure

[0044] The absorbent core according to the present invention can include other optional components normally present in absorbent webs. For example, a reinforcing scrim can be positioned within the respective layers, or between the respective layers, of the absorbent core. Such reinforcing scrims should be of such configuration as to not form interfacial barriers to fluid transfer. Given the structural integrity that usually occurs as a result of thermal bonding, reinforcing scrims are usually not required for thermally bonded absorbent structures.

[0045] Another component which can be included in the absorbent core according to the invention, and preferably is provided close to or as part of the primary or secondary fluid distribution layer or the fluid storage layer, are odor control agents such as zeolites, carbon black, silicates, EDTA or other chelates. Such agents are preferably provided in particulate form or as part of particles and can be provided together with the absorbent gelling material mentioned supra.

#### Backsheet

[0046] The absorbent article according to the present invention also comprises a breathable backsheet. The backsheet primarily has to prevent the exudates absorbed and contained in the absorbent structure from wetting articles that contact the absorbent product such as underpants, pants, pyjamas, undergarments, and shirts or jockets, thereby acting as a barrier to fluid transport. In addition however, the breathable backsheet of the present invention permits the transfer of at least water vapour, preferably both water vapour and air through it and thus allows the circulation of air into and water vapour out of the article. The backsheet typically extends across the whole of the absorbent structure and can extend into and form part or all of sideflaps, side wrapping elements or wings, if present. The backsheet according to the present invention is provided by at least a first layer.

[0047] According to a preferred embodiment of the present invention a dual or multiple layer breathable backsheet composite is used in the absorbent article. According to the present invention suitable breathable backsheets in such embodiments comprise at least a first and a second layer with said first layer being an air permeable layer. Preferred breathable backsheets for use herein are those having a high vapour exchange, most preferably both a high vapour and high air exchange.

[0048] The first layer is indicated as layer 50 in Figure 1. It is positioned on the garment facing surface of the absorbent core and on the wearer facing surface of the second layer which is indicated as layer 52 in Figure 1. It is oriented such that it retards or prevents liquid from passing from the absorbent core towards the outside while allowing free air flow through it.

The first layer

**[0049]** The first layer of the backsheet is provided by the film according to the present invention. It is preferably in direct contact with the absorbent core. It provides air and water vapour permeability by being apertured. Preferably this layer is made in accordance with the aforementioned US-A-5,591,510 or PCT WO- 97/03818, WO-97/03795. In particular, this layer comprises a polymeric film indicated in figure 1 as first layer (50), having capillaries (54). The capillaries extend away from the wearer facing surface of film (50) at an angle which is less than 90 degrees. In figures 2 through 7 alternative embodiments of such capillaries are shown. Preferably the capillaries are evenly distributed across the entire surface of the layer, and are all identical. However, layers having only certain regions of the surface provided with apertures, for example only an area outside the region aligned with the central loading zone of the absorbent core, maybe provided with capillaries according to the present invention.

**[0050]** Methods for making such three-dimensional polymeric films with capillary apertures are identical or similar to those found in the apertured film topsheet references, the apertured formed film references and the micro-/macroscopically expanded film references cited above. Typically the film is heated close to its melting point and exposed through a forming screen to a suction force which pulls those areas exposed to the force into the forming apertures which are shaped such that the film is formed into that shape and, when the suction force is high enough, the film breaks at its end thereby forming an aperture through the film.

**[0051]** Various forms, shapes, sizes and configurations of the capillaries are possible and will be discussed in reference to figures 2 through 7 in the following. The apertures (53) form capillaries (54) which have side walls (56). The capillaries extend away from the wearer facing surface of the film (55) for a length which typically should be at least in the order of magnitude of the largest diameter of the aperture while this distance can reach up to several times the largest aperture diameter. The capillaries have a first opening (57) in the plane of the garment facing surface of the film (55) and a second opening (58) which is the opening formed when the suction force (such as a vacuum) in the above mentioned process creates the aperture. Naturally the edge of the second opening (58) may be rugged or uneven, comprising loose elements extending from the edge of the opening. However, it is preferred that the opening be as smooth as possible so as not to create a liquid transport entanglement between the extending elements at the end of the second opening (58) of the capillary (54) with the absorbent core (44) in the absorbent article (in contrast this may be desirable for apertured film topsheets where such loose elements provide the function of sucker feet).

**[0052]** As shown in figure 4 the first opening has a center point (157) and the second opening also has a center point (158). These center points for non-circular openings are the area center points of the respective opening area. When connecting the center point (157) of the first opening (57) with the center point (158) of the second opening (58) a center axis (60) is defined. This center axis (60) forms an angle (59) with the plane of the film which is the same plane as the garment facing surface of the film (55). This angle should be preferably in the range between 85 and 20 degrees, more preferably between 65 degrees and 25 degrees, and most preferably between 55 and 30 degrees.

**[0053]** It is of course possible to allow the capillaries to take the shape of a funnel such that the second opening (58) is (substantially) smaller than the first opening (57) when considering the opening size in a plane perpendicular to the center axis (60). Such an embodiment is shown in figure 3 and figure 2. In figure 2 it is also shown that the wall (56) of the capillary may not end in the second opening (58) such that the opening forms a surface perpendicular to the center axis (60) but such that the wall on the portion of the capillary further apart from the wearer facing surface of the film (55) extends over the opening to further aid the film in reducing the probability of liquid migrating through the capillaries from the absorbent core on the wearer facing side of the film (55) to the garment facing side of the film (and cause leakage).

**[0054]** In figure 5 another embodiment of the capillaries useful for the present invention is shown which is curved along its length towards the wearer facing surface of the film (55). This has a similar effect as the extension of the wall (56) as shown in figure 2.

**[0055]** In figure 6 another preferred embodiment of a capillary according to the present invention is shown which has a first portion (257) and a second portion (258). The first portion (257) of the capillary is different in direction than the second portion (258) of the capillary (54). This difference can also be in shape, size, and form of the portions of the capillary in order to achieve the desired level of breathability while preventing liquid passage through the film in a direction from the wearer facing side towards the garment facing side. Such an example is shown in figure 7.

**[0056]** Without wishing to be bound by theory it is believed that the capillaries according to the present invention in a film of the present invention allow air and water vapour permeability which is not hindered by them being slanted at an angle or by the shape as indicated above. At the same time the slanting and shaping according to the present invention will allow the capillaries to close under pressure excerpted from the wearer facing side on them such that liquid transport through the capillaries towards the outside of the article becomes nearly impossible. Hence these three-dimensional formed film layers are highly preferable in the context of breathable absorbent articles and in particular so if an additional second outer layer is provided.

**[0057]** According to the present invention the polymeric material used for the apertured film is a conventional poly-



meric material such as a polyethylene (LDPE, LLDPE, MDPE, HDPE or laminates thereof) or a polypropylene or a monolithic polymer material. Especially using a monolithic polymer film as the material for the first layer provides water vapor permeability even under stress conditions. While the apertures provide air permeability during "leakage safe" situations but close the capillaries under stress conditions the monolithic material maintains water vapor permeability in such a case. Preferred breathable monolithic film materials for use herein are those having a high vapor exchange. Suitable monolithic films include Hytrel (TM), available from DuPont Corporation, USA, and other such materials as described in Index 93 Congress, Session 7A "Adding value to Nonwovens", J-C. Cardinal and Y. Trouilhet, DuPont de Nemours international S.A, Switzerland.

#### Resin integrated hydrophobicity increasing compound

**[0058]** The conventional polymeric materials of the present invention are "naturally" hydrophobic already. According to the present invention the film is made from such a polymeric material together with an additional compound which increases the hydrophobicity of the material. A definition of what is meant by the term hydrophobicity can be found in published PCT application no. PCT/US96/20685.

**[0059]** Typically, a drop of liquid placed on a solid surface makes a contact angle, A, with the solid surface. As the wettability of the solid surface by the liquid increases, the contact angle, A, decreases. As the wettability of the solid surface by the liquid decreases, the contact angle, A, increases. The liquid-solid contact angle may be determined from techniques known in the art, such as those described in greater detail in Physical Chemistry of Surfaces, Second Edition, by Arthur W. Adamson (1967), F. E. Bartell and H. H. Zuidema, J. Am. Chem. Soc., 58, 1449 (1936), and J. J. Bikerman, Ind. Eng. Chem. Anal. Ed., 13,443 (1941), each of which are hereby incorporated herein by reference. More recent publications in this area include Cheng, et al., Journal of Colloids and Surfaces 43:151-167 (1990), and Rothenburg, et al., Journal of Colloid and Interface Science 93(1):169-183 (1983), which are also hereby incorporated herein by reference.

**[0060]** As used herein, the term "hydrophilic" is used to refer to surfaces that are wettable by aqueous fluids (e.g., aqueous body fluids) deposited thereon. Hydrophilicity and wettability are typically defined in terms of contact angle and the surface tension of the fluids and solid surfaces involved. This is discussed in detail in the American Chemical Society publication entitled Contact Angle, Wettability and Adhesion, edited by Robert F. Gould (Copyright 1964), which is hereby incorporated herein by reference. A surface is said to be wetted by an aqueous fluid (hydrophilic) when the fluid tends to spread spontaneously across the surface. Conversely, a surface is considered to be "hydrophobic" if the aqueous fluid does not tend to spread spontaneously across the surface.

**[0061]** The liquid /solid contact angle depends on surface inhomogeneities (e.g., chemical and physical properties, such as roughness), contamination, chemical/physical treatment of or composition of the solid surface, as well as the nature of the liquid and its contamination. The surface energy of the solid also influences the contact angle. As the surface energy of the solid decreases, the contact angle increases.

**[0062]** The energy required to separate a liquid from a solid surface (e.g., a film or fiber) is expressed by equation (1):

$$(1) W=G(1+\cos A)$$

where:

W is the work of adhesion measured in erg/cm<sup>2</sup>, (x10<sup>-3</sup>Jm<sup>-2</sup>)

G is the surface tension of the liquid measured in dyne/cm, (x10<sup>3</sup>Nm<sup>-1</sup>) and

A is the liquid-solid contact angle measured in degrees.

**[0063]** For a given liquid, the work of adhesion increases with the cosine of the liquid-solid contact angle (reaching a maximum where the contact angle A is zero).

**[0064]** Work of adhesion is one useful tool in understanding and quantifying the surface energy characteristics of a given surface for a given liquid.

**[0065]** Table 1 is useful to illustrate the relationship between solid-liquid contact angle and work of adhesion for a particular fluid (e.g., water), whose surface tension is 75 dynes /cm (75x10<sup>-3</sup>Jm<sup>-2</sup>)

Table 1

A (degrees)	cos A	1 +cos A	W (erg/cm <sup>2</sup> ) (x10 <sup>-3</sup> Jm <sup>-2</sup> )
0	1	2	150



Table 1 (continued)

A (degrees)	cos A	1 +cos A	W (erg/cm <sup>2</sup> ) (x10 <sup>-3</sup> Jm <sup>-2</sup> )
30	0.87	1.87	140
60	0.5	1.50	113
90	0	1.00	75
120	-0.5	0.5	38
150	-0.87	0.13	10
180	-1	0	0

[0066] As depicted in Table 1, as the work of adhesion of a particular surface decreases (exhibiting a lower surface energy of the particular surface), the contact angle of the fluid on the surface increases, and hence the fluid tends to "bead up" and occupy a smaller surface area of contact. The work of adhesion, therefore, influences interfacial fluid phenomena on the solid surface.

[0067] The preferred material to be integrated into the polymeric material should be a fluoro chemical compound. Such compounds are well known from the art and have been discussed in detail in US 5,342,413, US 5,099,026, EP-A-260 011, EP-A-814 190, US 5,151,321, and US 5,178,931. The disclosure of which are incorporated herein by reference.

[0068] From these disclosures it was clear to the man skilled in the art how to achieve a hydrophobicity increase. However it was not known that using this technology for apertured films (particularly in the backsheet of breathable absorbent articles) can provide a synergistic effect on the barrier performance of these materials while simplifying the process to provide hydrophobicity.

[0069] It was conventionally thought that creating a surface energy gradient in this context would require surface treatment of a film or layer. However already the presence of this resin integrated hydrophobic compound in the layer through which capillaries are formed does prevent liquid from being transported through the capillaries. Paired with the extremely beneficial slanted capillary technology according to the present invention the resulting film layer has shown to provide extra ordinary and so far not obtainable barrier functions against liquid passage which even allows to use it as the only layer in the backsheet of an absorbent article.

#### The optional second layer

[0070] According to the present invention the second layer (52), if present, needs to provide at least water vapour permeability so as to support breathability of the article. It is not required but desirable that it also supports air permeability in order to further improve the comfort benefit from the breathability of the article. In this context suitable water vapour and air permeable layers include two-dimensional micro- or macro-apertured films, which can also be micro- or macroscopically expanded films, formed apertured films and monolithic films, as well as nonwovens, or wovens. They can also be provided with the resin integrated hydrophobicity increasing component as mentioned above.

[0071] Suitable 2 dimensional planar layers of the backsheet may be made of any material known in the art, but are preferably manufactured from commonly available polymeric materials. Suitable materials are for example Goretex (TM) or Sympatex (TM) type materials well known in the art for their application in so-called breathable clothing. Other suitable materials include XMP-1001 of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota, USA and Exxaire XBF-101W, supplied by the Exxon Chemical Company. As used herein the term 2 dimensional planar layer refers to layers having a depth of less than 1mm, preferably less than 0.5mm, wherein the apertures do not protrude out of the plane of the layer. The apertured materials for use as a backsheet in the present invention may be produced using any of the methods known in the art such as described in EP-A-293 482 and the references therein. In addition the dimensions of the apertures produced by this method may be increased by applying a force across the plane of the backsheet layer (i.e. stretching the layer).

[0072] Suitable apertured formed films include films which have discrete apertures which extend beyond the horizontal plane of the garment facing surface of the layer towards the core thereby forming protuberances. The protuberances have an orifice located at its terminating end. Preferably said protuberances are of a funnel shape, similar to those described in US 3, 929,135. The apertures located within the plane and the orifices located at the terminating end of protuberance themselves maybe circular or non circular provided the cross sectional dimension or area of the orifice at the termination of the protuberance is smaller than the cross sectional dimension or area of the aperture located within the garment facing surface of the layer. Preferably said apertured preformed films have a directional liquid transport and are positioned such that they support the prevention of liquid loss (leakage) through the backsheet. Suitable macroscopically expanded films for use herein include films as described for example in US 4 637 819 and US 4 591 523.

[0073] Suitable monolithic films include Hytrel (TM), available from DuPont Corporation, USA, and other such materials as described in Index 93 Congress, Session 7A "Adding value to Nonwovens", J-C. Cardinal and Y. Trouilhet, DuPont de Nemours international S.A, Switzerland. Suitable non-wovens and/or wovens are any of those well known in the art. Non-wovens such as spunbonded, melt blown or carded which are thermobonded airlayed, drylaid or even wetlaid with or without binder can be used. Particularly preferred non-wovens are multilayer non-wovens such as a composite of fine melt blown fibers with more coarse spunbonded fibers with the meltblown fibers forming the wearer facing surface of the non-woven layer.

#### Absorbent article construction

[0074] A further aspect of a preferred embodiment of the present invention relates to the joining of the topsheet, backsheet and absorbent core elements to provide the absorbent article. According to the present invention at least two, preferably all of the elements of the article are joined.

[0075] Each of said elements comprising at least one layer has a wearer facing surface and a garment facing surface. Typically, adjacent garment facing surfaces form a common interface with the wearer facing surface of adjacent elements or layers. The elements or layers are joined together across this common interface. In this manner the topsheet is joined to the absorbent core, and the core is joined to the backsheet. Furthermore, each of said topsheet, backsheet and core elements may comprise more than one layer and these layers may also be similarly joined. In addition the topsheet may be directly or indirectly joined to the backsheet at the periphery of the absorbent article to contain the absorbent core.

[0076] The elements and layers thereof may be joined by any means known in the art for affixing two adjacent layers of material, such that the layers are directly attached to one another or directly attached to one another via the joining means. Suitable joining means include adhesive, fusion bonding, ultra sonic bonding, stitching, heat (e.g. thermobonding by welding fibers at intersections or melting a polymer to attach fibers or films to each other), embossing, crimping, pressure bonds, dynamic mechanical bonds or combinations thereof. According to an embodiment of the present invention the preferred means of joining is adhesive. Suitable adhesives include non pressure sensitive and cold adhesives. The adhesive may be applied by any means known in the art such as spiral application, slot coating, spraying, spiral spraying, curtain coating, contact coating and printing, provided that the adhesive does not substantially affect the breathability and other functions of the elements of the article.

[0077] Maintaining breathability can be achieved by using particular adhesive application methods such as open adhesive application techniques, whereby areas of the common interface are adhesive free, whilst retaining the required level of attachment/joining of the two adjacent layers or elements. In particular spiral spraying is preferred.

[0078] In a preferred embodiment of the present invention wherein the absorbent article finds utility as a sanitary napkin or panty liner, the absorbent article is also provided with a panty fastening means which provides means to attach the article to an undergarment. For example the panty fastening means may comprise a mechanical fastener such as hook and loop fasteners such as marketed under the tradename VELCRO, snaps or holders. Alternatively, the article is fastened to the undergarment by means of panty fastening adhesive on the backsheet. The panty fastening adhesive provides a means for securing the article to the panty and preferably a means for securing the article when soiled, to the fold and wrap package for convenient disposal. Typically, at least a portion of the garment facing surface of the backsheet is coated with adhesive to form the panty fastening adhesive. Any adhesive or glue used in the art for such purposes can be used for the panty fastening adhesive herein. Pressure sensitive adhesives are most preferred. Suitable adhesives include Century A-305-IV manufactured by the Century Adhesives Corporation of Columbus, Ohio, and Instant LOK 34-2823 manufactured by the National Starch and Chemical Company of Bridgewater, New Jersey, 3 Sigma 3153 manufactured by 3 Sigma and Fuller H-2238ZP manufactured by the H.B. Fuller Co.

[0079] In order to reduce the adverse effect on breathability of the backsheet (and thus of the article as a whole), the adhesive is preferably applied such that at least 60%, preferably from at least 80%, most preferably at least 90% of the surface of the backsheet is adhesive free. The required adhesiveness can still be achieved even when using reduced surface coverage by using a particular distribution such as thinner strips, discontinuous strips of adhesive, intermittent dots, random patterns or spirals.

[0080] The panty fastening adhesive is typically covered with a removable release paper or film in order to prevent the adhesive from drying out or adhering to another surface other than the panty prior to use. Any commercially available release paper or film may be used. Suitable examples include BL 30MG-A SILOX EI/O and BL 30 MG-A SILOX 4 P/O available from Akrosil Corporation.

[0081] According to the present invention the absorbent article can be used beneficially in the context of sanitary napkins, panty liners, incontinence articles, sweatpads and diapers. However, sanitary napkins are particularly susceptible to the present invention. The disposable article may thus also have all those features and parts which are typical for products in the context of their intended use.

## Claims

1. A resilient, three dimensional web consisting of a liquid impervious polymeric film (55) having apertures (53), said apertures (53) forming capillaries (54), said capillaries (54) having side walls (56) which extend away from said wearer facing surface of said film (55), said capillaries (54) having a first opening (57) in said first surface of said film (55) and a second opening (58) at the end of said capillaries (54) spaced apart from said second surface of said film (55)
 

said capillaries (54) extend away from said second surface of said film (55) at an angle (59) of less than 90° measured from the plain of said film

said web being characterized in that

said polymeric film comprises a resin integrated fluoro-chemical compound such that the contact angle with water is increased when comparing with the polymeric material without the fluoro-chemical compound.
2. Breathable disposable absorbent article of layered construction, each layer or system of layers having a garment facing surface, which is oriented to face in the direction of a garment (21) during use of the article, and a wearer facing surface, which is oriented to face in the direction of the wearer (20) during use of the article comprising at least
  - an absorbent core (40, 42, 44);
  - a breathable backsheet (50, 52) located on said garment facing surface of said absorbent core (40, 42, 44), said backsheet (50, 52) comprising at least a first backsheet layer (50) said first backsheet layer (50) being positioned a said garment facing surface of said absorbent core (40, 42, 44), said first layer (50) being water vapor and air permeable, said first backsheet layer (50) comprising a resilient, three dimensional web, said web consists of a liquid impervious polymeric film (55) having apertures (53), said apertures (53) forming capillaries (54), said capillaries (54) having side walls (56) which extend away from said wearer facing surface of said film (55), said capillaries (54) having a first opening (57) in said first surface of said film (55) and a second opening (58) at the end of said capillaries (54) spaced apart from said second surface of said film (55)

said capillaries (54) extend away from said second surface of said film (55) at an angle (59) of less than 90° measured from the plain of said film.

said article being characterised in that

said polymeric film comprises a resin integrated fluoro-chemical compound such that the contact angle with water is increased when comparing with the polymeric material without the fluoro-chemical compound.
3. Breathable disposable article according to claim 2 characterised in that it further comprises a second layer (52) being provided by a water vapour and air permeable nonwoven material, and in that said wearer facing surface of said second layer (52) is the wearer facing surface of said backsheet (50, 52).
4. Breathable disposable article according to any of the claims 2 to 3 characterised in that the increase of said contact angle with water is at least 5°, preferably 20°.
5. Breathable disposable article according to any of the claims 2 to 4 characterised in that the contact angle with water of the polymeric film is more than 100°, preferably more than 120°.
6. Breathable disposable article according to any of the claims 2 to 5 characterized in that said resin integrated fluoro-chemical compound is selected from oxazolidinones which are substituted with a fluoro-aliphatic material.
7. Breathable disposable article according to any of the claims 2 to 6 characterised in that said first opening (57) of each of said capillaries (54) has a center point (157) and said second opening of each of said capillaries also has a center point (158) and a line connecting said center points defines a center axis (60) of each of said capillaries (54), said center axis (60) forming an angle (59) with the plain of said film (55), said angle being between 85° and 20°, preferably between 65° and 25°, most preferably between 55° and 30°.
8. Breathable disposable article according to any of the claims 2 to 7 characterised in that at least some of said

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capillaries form cones having liquid transport which are reducing in a direction areas towards the absorbent core (40, 42, 44) when comparing areas perpendicular to said center axis (60).

- 5 9. Breathable disposable article according to any of the claims 2 to 8 characterised in that said second opening (58) at least of some of said capillaries has generally the form of a slit having a length which is at least 5 times as large as the width of said slit.

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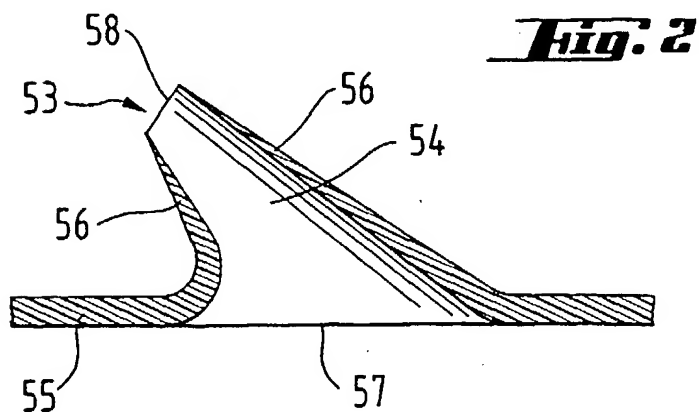
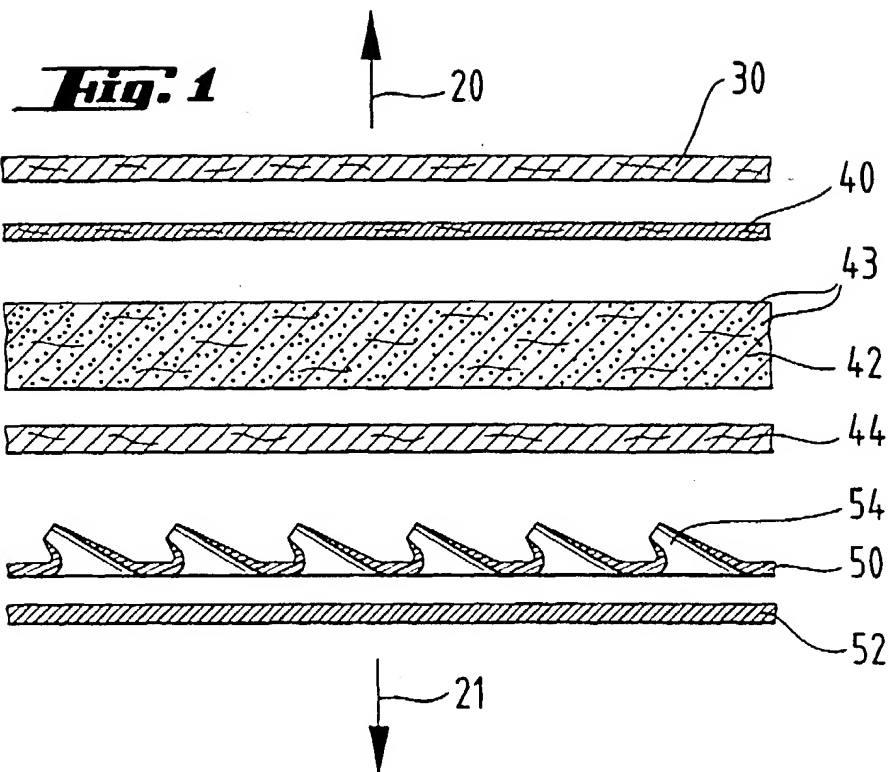
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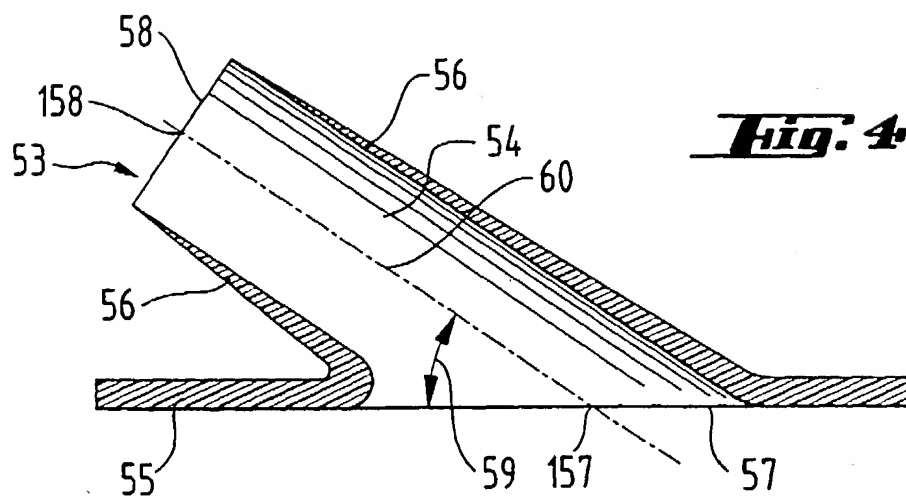
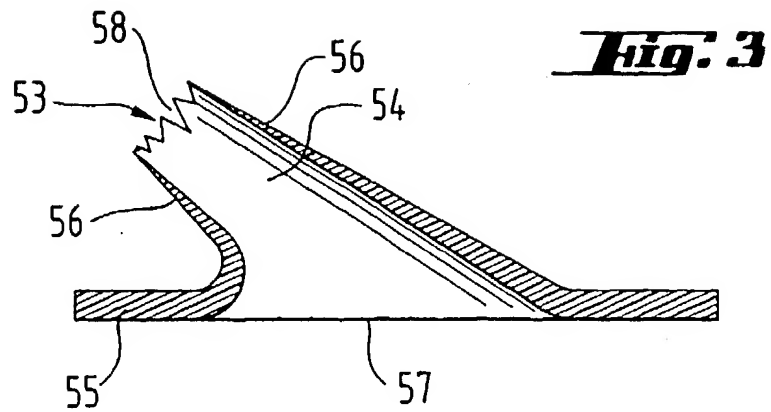
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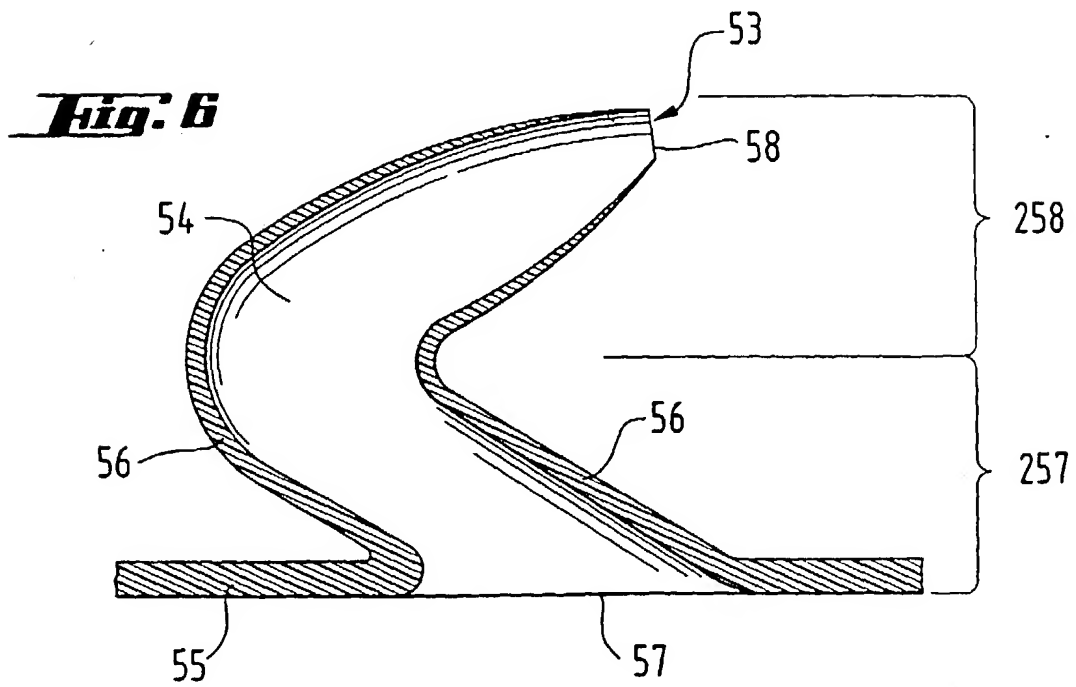
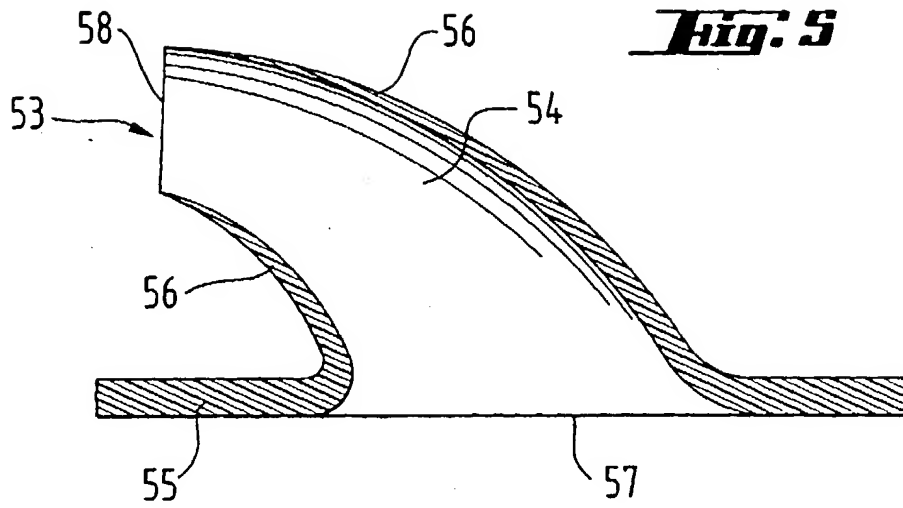
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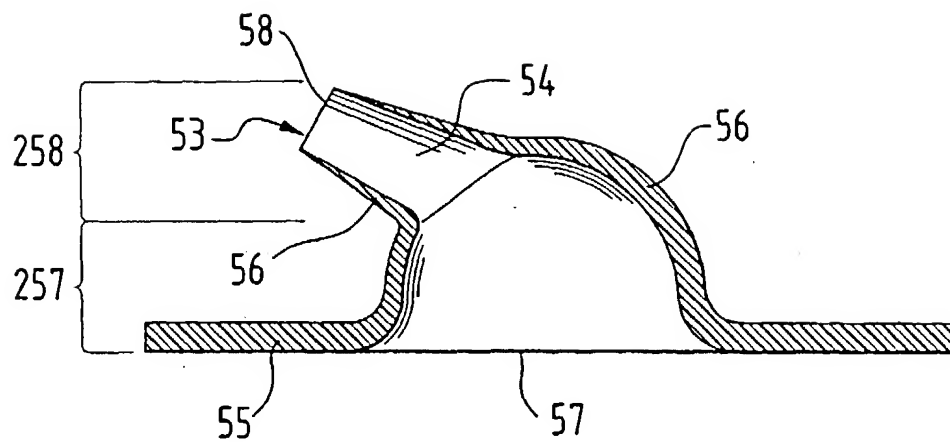
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***Fig. 1***



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